

A large background image showing a man with dark curly hair and a young boy with blonde hair embracing each other. The man is on the right, looking towards the boy on the left. They are both smiling. The man is wearing a dark blue sweater over a light-colored shirt. The boy is wearing a light blue sweater. The background is a soft, bright white light.

Get the Facts



Growth Hormone Issues in  
Children and Adults



THE HORMONE FOUNDATION



# Your Hormones

**H**ormones are substances formed in a type of body organ called a gland. A hormone is then carried in the circulation to another organ or tissue where it has a specific effect. Growth hormone (GH) is a very important hormone that can influence your health in many ways. It is powerful enough to alter the way you look, feel, and function.

Growth hormone is produced by the pituitary gland. When absent or inadequate, there can be many different effects in children, adolescents, and adults. Several different conditions can affect the way that a body produces GH or whether it is produced at all. This booklet covers conditions in which GH is abnormally produced, and is written for you as parents of children with growth or GH disorders or as an adult with a GH-related condition.

Biosynthetic growth hormone, which is made in laboratories, is proving to be a valuable treatment for many medical conditions. Some of the diseases that benefit from growth hormone therapy are very complicated and may require several diagnostic tests and more than one type of treatment.

All of the conditions affecting growth hormone production are studied and treated by doctors called endocrinologists. These doctors are specially trained to identify, diagnose, and treat growth disorders and other hormone-related conditions. Your regular doctor may refer you to an endocrinologist when you or your child has a problem with the endocrine (glandular) system.

# Children

## *Growth Hormone Deficiency in Children*

A child with growth hormone deficiency (GHD) does not produce enough GH, and the growth rate slows. Without treatment, your child may be very short for his or her age and as an adult.

Most children with GHD grow less than two inches per year; other children usually grow at least two inches yearly. Often children with this condition grow normally until the age of two or three years, when their growth becomes noticeably slow. Other children may have slow growth before they are toddlers, even from birth. Even though these children are short, they have normal proportions of the trunk and extremities.

Your child with GHD may deposit more fat in the abdomen and face and have decreased blood sugar levels. Children with GHD may be sad or upset about their height, weight, or other aspects of their life, because of their shortness and body image. Children with this condition also tend to look younger than other children of the same age and may be slow to show signs of maturing sexually at the age of adolescence.

If your child shows signs of GHD, his or her doctor may take a very detailed medical history, and ask about the height of relatives and when they went through puberty. A doctor also may order tests to learn about the function of the kidneys, bones, and thyroid gland. In addition, the doctor will order a hand X-ray to examine bone maturation. The doctor also will study your child's pituitary gland to check for possible damage. This will require a series of blood tests to measure growth hormone and other factors. In addition it is likely that a special imaging study of the head will be done to evaluate the brain and structure of the pituitary gland.

### **Safety and GH Treatment**

Because biosynthetic (artificially made) growth hormone is taken for years as treatment, it is good for parents of children with GHD to be aware of some safety precautions:

- Carefully follow the directions for taking GH;
- Tell all doctors who care for your child that he or she is taking growth hormone;
- Make sure your child takes any other prescription drugs exactly as prescribed; and
- Contact your child's doctor immediately if you have any questions about treatment.

### **Possible Adverse Events**

- Pseudotumor Cerebri (pressure and swelling within the skull)
- Edema (swelling)
- Slipped Femoral Epiphysis (separation of the ball of the hip joint from the thigh bone)

If it is determined that your child has GH deficiency, it may be a congenital problem, one that has been there since your child was born. Other conditions can damage the pituitary gland, which produces GH, including a tumor, infection, or radiation treatments for tumors of the head and neck region.

If diagnosed and treated early, children with GH deficiency are able to grow to a height in keeping with their family history, in most cases. Psychological counseling can help children work through other problems that may be related to the condition, such as poor self-esteem or feeling unhappy.

## *Chronic Renal Insufficiency*

Each year, about 3,000 children suffer from chronic renal (kidney) insufficiency (CRI). As the kidneys begin to fail, toxins accumulate in the child's blood stream that prevent normal growth.

The FDA has approved GH treatment for children with CRI because it is effective in stimulating growth. An endocrinologist or pediatric nephrologist can help you decide whether GH is an appropriate treatment if your child has growth problems because of CRI.

## *Small-for-Gestational Age*

Perhaps your child did not grow normally during pregnancy. Your baby was born small for its gestation (time growing inside of the mother), a condition also known as intrauterine growth restriction (IUGR). IUGR babies may spend a full term in their mother's uterus and still do not grow to average size.

Many conditions can cause IUGR, including parental factors such as maternal nutrition, infectious disease, environment (such as a mother who drinks alcohol to excess), or other factors.

Studies have shown that giving GH treatment to children with IUGR who have not "caught-up" to the normal growth curves by age two may speed up growth. One 1997 study, for example, showed that catch-up growth, a faster than average rate of growth, was reached in the majority of children getting GH therapy. High rates of growth continued through the children's second year of the study, and there were no adverse effects from the treatment.

Longer term clinical studies are needed to learn how long GH should be given and at which ages to benefit a child with IUGR.

## *Turner Syndrome*

Turner syndrome (TS) is caused by a chromosomal abnormality. A syndrome is a group of characteristics that when they appear together identify a disorder. No one knows exactly why a chromosome may be missing or broken, but girls with TS usually are much shorter than girls their same age who are of normal height and may not progress normally through puberty. This abnormality is found in about 1 in 2,500 girls.

Because a girl with TS is missing genetic material on a sex chromosome, the X chromosome, her ovaries usually do not develop normally, and she does not grow to reach her full height potential.

These are some ways that TS may affect your daughter:

- TS average height is 4' 8"; average American female is 5' 5"
- Ovarian failure (failure for a girl to produce eggs, go through puberty, and have a menstrual cycle so that she can become pregnant when older)
- She may have heart, kidney, or thyroid problems

Other physical features of TS may be present:

- Puffy hands and feet at birth
- Broad chest with the appearance of widely spaced nipples
- Webbed neck
- Prominent ears
- Low hairline
- Small jaw
- Narrow, high-arched palate
- Arms that turn out at elbow
- Soft fingernails that turn up at the ends
- Short fingers
- Small brown moles on skin

If your daughter has TS, she is unlikely to be GH deficient, but the extra growth that GH could provide may have a beneficial effect on her life. Thus, if treated early, she can be expected to reach an adult height within the normal range.

Clinical trials over the past decade have provided strong proof of the effect of GH on short-term growth; more studies are needed to show the impact on adult height, although most studies to date indicate a positive effect on adult height.

Many girls with TS also take estrogen (female reproductive hormone) around the time of puberty so that they can go through sexual maturation along with their peers. Puberty can be a confusing time of life for any girl or boy, especially if physical differences are involved. During this time, your daughter may benefit by talking to other girls and women who have TS.

## Chromosomes and Growth Conditions

In everyone's body, each cell contains tiny twisted strings of molecules called chromosomes that contain genes, which tell cells how they will grow and what they must do. Humans have 23 pairs of chromosomes, and each parent contributes one of each pair. They are numbered and arranged by size when they are analyzed in labs.

The 23rd pair, for example, is the sex chromosome pair. A mother and father each contribute a sex chromosome to the child. Girls have two Xs (one from the mother and one from the father), while boys have one X (from mother) and one Y (from father) chromosome.

Sometimes, however, a chromosome or piece of a chromosome may be missing. In Turner syndrome, only one normal X chromosome is present.

In another example, a child with Prader-Willi syndrome (PWS) may be missing all or part of chromosome 15.

## *Prader-Willi Syndrome*

Prader-Willi syndrome (PWS) is named for two of the doctors who recognized and explored the syndrome in 1956. Like Turner syndrome, PWS is a genetic condition (see box on page 5).

PWS is an uncommon genetic condition that will affect your child's life, sometimes in life-threatening ways. It occurs once in every 10,000 to 12,000 births. In utero, prenatally the child often is less active than his/her siblings were.

A PWS newborn has:

- Poor muscle tone (floppy baby)
- Poor ability to suck or nurse, with poor weight gain

In the toddler years, however, the PWS child has:

- Constant appetite
- Preoccupation with eating
- Weight gain, which in some cases becomes life-threatening

Other features of PWS include centrally distributed obesity, short stature, small hands and feet, a small mouth, almond-shaped eyes, and smaller than usual genitals with a delay in puberty. Your child may also have difficulty learning or cognitive impairments, behavioral problems or emotional problems.

Early diagnosis is the key to helping your child with PWS stay as healthy as possible.

Using a standard dose of GH given to children with GHD, most Prader-Willi children have shown noteworthy increases in linear growth, a decrease in body fat and an increase in lean body mass, sometimes with improvement in physical activity and in respiratory function.

However, children with PWS may have risk factors that prevent them from taking GH. The following children with PWS should not take GH for their condition:

- Children who are very obese
- Children with breathing problems or sleep apnea (breathing stops temporarily during sleep)
- Unidentified respiratory infection

Patients with Prader Willi syndrome who take GH treatment need to be careful about some other things. They need to be assessed for upper airway blockage before they begin GH treatment. If these airways become blocked or snoring increases during GH treatment, treatment should be stopped and the child should be medically evaluated.

They should be assessed for sleep apnea and monitored for this condition. They should also have their weight controlled and be watched for signs of respiratory infections, which need to be treated urgently. Scientists are still learning about the long-term risks and benefits of GH treatment for children with PWS.

## Idiopathic Short Stature

Some children fail to grow to a height that is within the normal range. This condition, idiopathic short stature (ISS), has been defined as a height that is far below the average for a child's age and sex (more than two standard deviations below the average height). This definition covers the shortest 2.3 percent of children. These children are normal physically and they do not have a known cause for their short stature. The rate at which their bones mature is either delayed or normal.

Recently, the Food and Drug Administration (FDA) approved the use of GH treatment for extremely short but otherwise healthy children who are still growing. These children must be among the shortest 1.2 percent of children (more than 2.25 standard deviations from average height). The FDA agreed to approve the drug for children who are unlikely to catch up on height at their own rate of growth. For example, for 10-year old boys and girls, this would mean a height of less than 4'1" or predicted adult heights of less than 5'3" and 4'11" in adult men and women, respectively.

A pediatric endocrinologist can determine if a child has ISS. This doctor will need to rule out other diseases, or GH-related conditions, before concluding that a child has ISS.

To diagnose ISS, a pediatric endocrinologist would complete a full physical exam, review the complete medical history of your child, and order blood and urine tests. The doctor would probably order an X-ray of your child's hand. Then the X-ray is compared to the bone maturation of other children the same sex and age. The doctor would also obtain hormone tests of your child, and probably also monitor your child's growth.

After reaching a diagnosis of ISS, the doctor and family members can discuss the benefits and risks of GH treatment.

The FDA decision to approve GH treatment for ISS was based on two clinical studies in children. One was a randomized placebo-controlled study and one was a dose-response study. There was an average height gain of 1.5 to 3 inches in the children who received GH treatment. According to an FDA Talk Paper (July 25, 2003), the safety profile of GH treatment in children with ISS was not different from the profile of other conditions for which GH is used. However, the long-term effects of treating children with ISS remain unknown at this time.

### Questions Raised About The FDA Decision Include:

- Is the possibility of a small increase in height enough of a reason to begin therapy in a healthy normal child?
- Does a child need to reach a certain height in order for this treatment to be worthwhile?
- Will GH treatment help the child become tall enough to pursue typical daily activities, such as being tall enough to drive a car?

**To find a pediatric endocrinologist who can provide assistance with these questions, visit [www.hormone.org](http://www.hormone.org)**

## *Constitutional Delay of Growth and Puberty*

Another form of slow growth is constitutional delay of growth and puberty. This means a child is lagging behind his or her peers in terms of maturing sexually and also in height.

If this is true of your child, it may be because parents or other family members underwent the same pattern of slow growth in height and slowness to reach puberty. A mother may have gotten her menstrual period later than other girls. A father may have continued to grow after the completion of high school.

Your child may eat normally, take in enough nutrients, and have normal physical examinations. However, because of the delay in reaching puberty and the growth spurt that accompanies maturation, your child may be shorter than other children. This condition is more commonly diagnosed in boys than girls.

Adolescents with this condition usually do not need treatment but sometimes do benefit from therapy.

If you seek treatment, a doctor would order X-rays of the hand bones and compare them with results of what is considered average for your child's age. Children with constitutional delay of growth and puberty tend to have bones that look younger than expected according to their age.

Treatment with sex steroids or anabolic steroids is an effective and safe way to help your child achieve secondary sexual characteristics. These children mature and grow taller as a result of pubertal changes. This treatment does not add to your child's final height but gets him/her there sooner.

To stimulate sexual maturity, boys could take a form of male hormone (an androgen, often testosterone). One therapy that is being studied includes the addition of an aromatase inhibitor that prevents the androgen from breaking down into estrogen, the hormone responsible for bone maturation. The aromatase inhibitor allows the boy to grow over a longer period of time. Girls could take estrogen to stimulate puberty. GH therapy might also play a role in this disorder if the child is not expected to achieve an adult height within the normal range.

## *Transition to Adult Growth Hormone Replacement*

A child who has had GHD may benefit from continuing GH treatment in adult life. An endocrinologist can help determine whether an adolescent needs to continue GH treatment as an adult.

Often children who had GH therapy during childhood can produce enough GH after puberty to control the effects of GH in adulthood. Adolescents need to be tested to determine whether they need to continue taking the hormone. Tests may show that they no longer need GH therapy as adults.

Other young adults may benefit from continuing to take GH because they remain growth hormone deficient. These adults will not grow taller, but they generally will keep off extra weight and body fat while taking GH. In general, when GH therapy ends, excess fat tends to form around the waist area and muscle mass decreases in adults with GHD. If you had GHD as a child and have stopped taking GH, you may not be able to perform heavy lifting or hard physical work for very long. You may have weaker, thinner bones, which could make your bones break more easily.

Psychological distress is also common among adults who had GHD as children and who have stopped taking GH. Continued hormone treatment may be important, and your endocrinologist can make the best recommendation for you.



**To find an endocrinologist, a doctor who specializes in hormones, log on to The Hormone Foundation's Web site at [www.hormone.org](http://www.hormone.org), or call 1-800-HORMONE for a referral.**

# Adults

## *Adult Growth Hormone Deficiency*

Adults who don't have enough growth hormone (GH), even those of normal height, can suffer from lack of energy, muscle weakness, emotional distress, and other problems. GH has an important role in controlling areas of your brain that involve emotions.

Adults who have growth hormone deficiency (GHD) fall into two categories:

- Those who had GHD as children and continue to have GHD in their adult years; and
- Those who grew and matured normally, but have had pituitary gland damage as adults and are not producing enough GH

### **Symptoms of GHD in adults include:**

- Increased fat around face and abdomen
- Lower level of lean body (muscle) mass
- Osteopenia (bone loss)
- Thinning skin with fine wrinkles
- Poor sweating or impaired temperature regulation
- Loss of interest in sex
- Sleep problems
- Decreased muscle strength
- Decreased exercise performance
- Decreased energy and vitality
- Higher cholesterol levels, especially LDL cholesterol (or “bad” cholesterol)
- Hyperinsulinemia (production of too much insulin, related to being overweight)
- Decreased well being; mild depression; or “moodiness”

If you are taking GH as an adult, you may see your muscle mass increase, even as you lose fat. GH also can improve your exercise performance and ability to use oxygen. Your “bad” cholesterol may be reduced.

One effect from GH treatment is that your mood or emotions could improve. You may feel like you have more energy.

### *Wasting Disease, Burns, and Trauma*

One other use for GH in adults has been approved by the FDA: GH for people whose bodies are under stress or wasting because of the effects of AIDS (Acquired Immune Deficiency Syndrome), burns, or traumatic injuries. In AIDS, the wasting syndrome is characterized by significant, unintended weight loss.

If you have AIDS and have lost a lot of weight, GH may help you gain weight. If you add a regimen of resistance exercise (weight-bearing workouts), you can accumulate more muscle.

Another study showed that after a trauma (severe injury), GH along with adequate daily nutrition helped to enhance metabolism

(chemical changes occurring in body tissue; for example, the body's ability to convert food efficiently into energy). Patients receiving GH also had fewer infections and were able to leave the hospital sooner than patients who did not receive GH.

Not all critically ill patients, however, benefit from GH. In a multicenter trial, researchers learned that patients who took GH treatment, most of whom had heart or abdominal surgery or acute respiratory failure, died at a greater rate than patients who received a placebo (medication that has no medical value). They may have done poorly because of certain metabolic and inflammatory effects of GH. Researchers concluded that because of increased risk in certain patient groups, GH should not be given to patients with critical illness other than burns or trauma.

## *GH as an Anti-Aging Treatment: Benefits and Risks*

GH levels decline as part of normal aging. In some people the levels become quite low. The FDA has not approved GH treatment for any anti-aging benefits, although GH does provide some physical benefits. It is not, however, the miracle drug that many say it is, trumpeted in ads on the Internet and elsewhere. Maybe you've read the claims about these wonderful anti-aging effects. Many of these advertisements talk about results from a clinical trial (Rudman and colleagues, published in 1990 in the *New England Journal of Medicine*), but that was a study of just 12 men over age 60, who were studied over such a short time that side effects probably did not have time to emerge, according to medical experts.

Studies of GH supplementation in healthy older subjects have shown that in both older men and women, GH increases muscle mass and decreases body fat. In a 6-month study, the combination of testosterone (a male hormone) and GH also increased strength in older men. In another study, one month of a small dose of GH (6.25 mcg/kg/d) alone or in combination with testosterone did not improve strength, flexibility, or percentage of body fat, but it improved some function and balance measures in healthy older men. In a third study, GH did not enhance the positive effect of exercise on muscle strength. In one study, however, negative effects were notable, such as increased risk of diabetes and glucose intolerance.

Therefore, it is still unclear whether GH is beneficial in the elderly overall. For example, while GH treatment helps to build lean body mass, researchers have not proven that it improves strength any more than going to the gym regularly, which is a less expensive option.

In reviewing all these findings, researchers concluded that GH treatment in elderly people should be limited to closely controlled studies. More studies are needed to evaluate the effects of GH on cancer, cardiovascular disease, diabetes and other conditions.

## *Lipids and Cardiovascular Disease*

Adults with GHD may have blood lipids (fat) abnormalities. GH therapy may correct these. Specifically, total cholesterol and low density lipoprotein cholesterol (known as “bad cholesterol”).

Scientists still don't understand the extent to which these changes in lipids can slow down the process of fatty build-up in the arteries (atherosclerosis). There have not been many studies to date that focus specifically on cardiovascular effects.

When adults with GHD are taking GH therapy, correct dose is very important for cardiovascular health. If too high a dose of GH is given, a patient's heart may become enlarged. What this means is still unclear. Thus, taking GH under the supervision of an endocrinologist or knowledgeable physician is very important.

## *Cardiomyopathy*

Cardiomyopathy refers to the inability of the heart to pump as it should because of a disease process that affects heart muscle. Researchers have been testing a theory that taking GH could help to build up heart muscle.

In some studies, several cardiac functions improved significantly, including pumping power and heart wall thickness. However, the risk of serious side effects needs to be examined further. These include an increased risk of death from cardiovascular and respiratory disease and possibly an increased risk of colon cancer.

Researchers still have to conduct studies on different types of dilated cardiomyopathy, dosage of growth hormone, how long treatment should last, and follow-up studies to learn how patients function after treatment.

## *Crohn's Disease*

Crohn's disease is a chronic inflammatory disorder of the bowel (intestines). In one study, researchers evaluated whether the administration of growth hormone (as well as a high-protein diet) would improve the symptoms of the disease. At four months, the Crohn's Disease Activity Index score had decreased significantly in the GH group, as compared with a much smaller decrease in the placebo group. Side effects included some swelling (edema) and headache, which usually went away during the first month of therapy.

Researchers need to study the effects of GH in further clinical trials to determine its value in treating Crohn's disease.

## *Psychosocial and Quality of Life Issues*

Some adults find their lives are much better after taking GH alone. Others may find they still need some help, particularly with the psychological symptoms of GHD.

You may need medication to control anxiety or lift your mood. You may find counseling helpful, too. Some forms of therapy, such as cognitive-behavior therapy, can help correct negative thoughts you may be having. You may want to join a support group with other adults who have GHD.

Because GHD can cause energy and strength problems, you should also try to eat a balanced diet and get regular exercise and plenty of sleep.

While GH treatment may help restore your feeling of being normal, this may not be enough. You may need to keep taking medication to control your anxiety or depression or try behavior-changing activities. Your doctor can help you find the support or treatment that is best suited to you.

## *Off-brand, Off-label and Non-approved Uses, and Oral Growth Hormone*

The old saying, “Let the buyer beware,” is especially true when it comes to unauthorized claims about growth hormone. In the care of a board-certified adult or pediatric endocrinologist, you can be assured that the growth hormone treatment you are receiving is one that you need in a dosage that suits you.

So far, the FDA has approved only two uses of GH for adults: to treat adult GHD and wasting diseases. As you’ve read in this brochure, clinical trials have shown that GH can benefit other people, and doctors are allowed to use GH to treat other conditions. These uses are not yet approved and are not on the growth hormone drug labels; thus, these are called “off-label” uses of GH. Your doctor should explain such usage to you and answer your questions completely.

Only certain brands of GH have been approved by the Food and Drug Administration. A generic or off-brand form of GH from a source that promises to save you money may not give you the true hormonal effects your body needs.

Unfortunately, with the Internet, a lot of false advertising that raises unrealistic hopes is mixed in with valuable, online medical information. For example, many different companies are touting oral growth hormone (taken by mouth, as opposed to injection). GH does not work in oral form because it is inactivated in the gut.

If you think you need GH treatment, consult an endocrinologist who is an expert in managing the treatment of hormone conditions. 

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## Resources

**Center for Drug Evaluation and Research, U.S. Food and Drug Administration (FDA)** – For information visit [www.fda.gov/cder](http://www.fda.gov/cder)

**The Endocrine Society** – 8401 Connecticut Avenue, Suite 900, Chevy Chase, MD 20815-5817. Phone: 1-800-HORMONE. For more information on growth hormone, visit [www.endo-society.org](http://www.endo-society.org)

**The Hormone Foundation** – 8401 Connecticut Avenue, Suite 900, Chevy Chase, MD 20815-5817. Phone: 1-800-HORMONE. For more information visit [www.hormone.org](http://www.hormone.org)

**Human Growth Foundation** – Falls Church, VA. Phone: 800-451-6434 or 703-883-1773. For more information visit [www.hgfound.org](http://www.hgfound.org)

**Kid's Health/The Nemours Foundation** – For more information visit [www.kidshealth.org](http://www.kidshealth.org)

**Lawson Wilkins Pediatric Endocrine Society** – 867 Allardice Way, Stanford, CA 94305. Phone: 650-494-3133. For more information visit [www.lupes.org](http://www.lupes.org)

**MAGIC Foundation** – Oak Park, IL. Phone: 800-3 MAGIC 3 (800-362-4423). For more information visit [www.magicfoundation.org](http://www.magicfoundation.org)

**Medline Plus (NIH/NLM)** – 8600 Rockville Pike, Bethesda, MD 20894. For more information visit [www.nlm.nih.gov/medlineplus](http://www.nlm.nih.gov/medlineplus)

**National Institutes of Health** – 9000 Rockville Pike, Bethesda, MD 20892. For more information visit <http://health.nih.gov>

**Prader-Willi Syndrome Association** – Sarasota, FL. Phone: 800-926-4797 or 941-312-0400. For more information visit [www.pwsausa.org](http://www.pwsausa.org)

**Turner Syndrome Society** – Phone: 800-365-9944. For more information visit [www.turner-syndrome-us.org](http://www.turner-syndrome-us.org)

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- National Institute of Diabetes and Digestive and Kidney Diseases. Growth Failure in Children with Kidney Disease; [www.niddk.nih.gov/health/kidney/summary/growthfail/index.htm](http://www.niddk.nih.gov/health/kidney/summary/growthfail/index.htm)

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